SOME SIMPLE PHYSIOLOGICAL APPARATUS

By George E. Stone

The writer has for many years conducted a physiological practicum connected with botanical teaching, and as might be expected in any course requiring experiments, many methods and devices have been incidentally developed, some of which have proved fairly satisfactory in demonstrating certain principles, and others may find them suggestive in their lines of work.

Method of Demonstrating Difference in Transpiration Between Upper and Lower Sides of the Leaf

For demonstrating the difference in transpiration between the upper and lower sides of the leaves we have used the apparatus shown in figures 1 and 2, which illustrate a calla plant with the apparatus in place. It consists of two simple hygrometers 5 cm. in diameter, similar to those often used in cigar cases. These are attached to two pieces of metal tubing slightly larger in diameter than the hygrometers, each tube being about 4.5 cm. long. The hygrometers are placed in the end of each tube by means of rubber sheeting cut so as to fit tightly around the hygrometers. The rubber is then turned over the end of the metal and tied on with a thread. The tubes containing the hygrometers are placed on either side of the leaf, the ends of the tubes being supplied with rubber rings or bands so that the two halves of the metal cylinder, each containing the hygrometer, can be pressed against the leaf firmly but without injuring it. Glass tubes or even large corks may be substituted for metal if the proper size is obtainable. By taking readings of both hygrometers at the beginning of the experiment and at different times afterwards the relative difference in the transpiration between the upper and lower sides of the leaf is fairly accurately determined.

Method of Demonstrating the Effects of Various Factors on Transpiration

There are many simple experiments which may be done to illustrate the effects of various factors on transpiration. In our

FIG. 1. Method of demonstrating the difference in transpiration between the upper and under side of the leaf by means of hygrometers.

laboratory we have for a number of years made use of the apparatus illustrated in figure 3, which consists of a wooden stand mounted on legs, as shown in the illustration. This stand supports a large bell glass containing two apertures and in the center of the wooden stand there is a hole about one-half inch in diameter through which the plant is inserted into a tube below. The stem of the plant is forced down through the cork stopper into the tube containing water. A piece of flexible rubber cloth is tied around the bottom of the bell glass. The stem of the plant is put through a slit in the rubber cloth which is fastened to the plant securely by means of thread. From the lower end of the larger tube containing the stem of the plant

there are two small glass tubes bent at right angles at the extreme end which are attached to a meter stick, the lower ends of which are submerged in a vessel of water. One of these tubes has a calibre of about three millimeters in diameter; the other of about one millimeter or more. If the plant is transpiring very

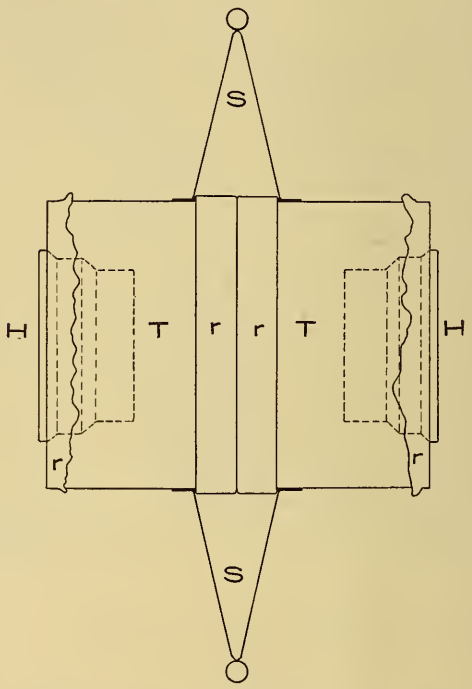

FIG. 2. Cross-section of transpiration apparatus. *T*, Metal tubes holding hygrometers. *H*, Hygrometers. *S*, Springs which hold the tubes close to the leaf. *r*, Rubber sheeting and bands.

freely the larger tube can be used, but if transpiring only slightly the smaller one will answer the purpose better. Connected with the large tube containing the stem is a reservoir or supply of water which is for the purpose of enabling the bubble to be placed anywhere on the scale desired by letting in water or by sucking it upwards. We have used this apparatus now for many years with considerable success. For our purpose we attach the bell-glass to a Chapman aspirator which enables one to draw air

of various degrees of saturation through the chamber, and by means of the bubbles the rate of transpiration can be determined. One can demonstrate the effects of ordinary laboratory air on transpiration or the effects of dry and moist air. The effects of dry air may best be determined by aspirating through sulfuric acid, which is much superior to calcium chloride. The effects of moist air may so be demonstrated by passing the air through water bottles, and the effects of warm air by heating very thoroughly a piece of gas pipe over a flame and aspirating air through it. In carrying on the various experiments a thermometer and

FIG. 3. Method of demonstrating effects of various factors on transpiration.

hygrometers may be placed under a bell-glass to indicate the changes in the air. This apparatus may be used to demonstrate the effects of chloroform, ether, illuminating gas, etc. on transpiration, and by the use of a simple mechanism the effects of movements or vibrations on the plant in the bell-glass may be determined, and in short, this apparatus may be used to demonstrate most of the fundamental factors underlying transpiration.

Devices for Percolating Air Through Soils

There is on the market a standard set of appliances adapted to the study of soil physics. Simple experiments to demonstrate the percolation of air and water through soils, capillarity, water retaining capacity, etc., are of value in connection with the study of respiration. An appliance is often used in connection with the experiments relating to the percolation of air through soils which is defective and unreliable, and the writer has made

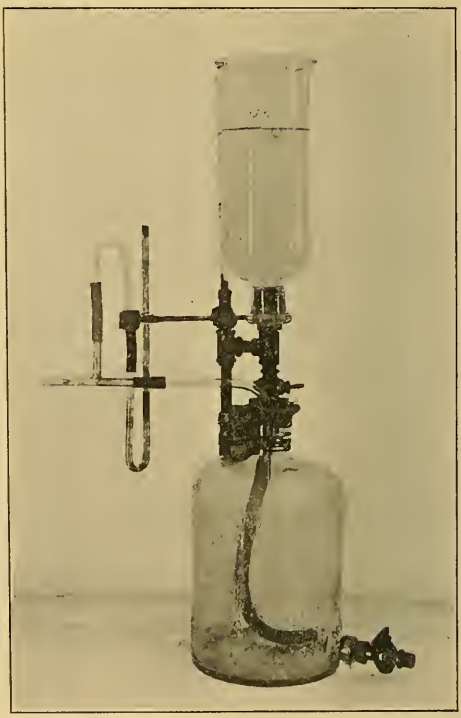

Fig. 4. Device for percolating air through soils.

use for a number of years of a form similar to that shown in figure 4. The principles underlying the present device for demonstrating the percolation of air through soils are not perfect, but the defects are of more theoretical than practical importance and could be easily remedied if necessary. The device

consists of a bottle holding about two gallons with an opening at the bottom provided with a valve. This is connected with a bell-jar overhead holding about a liter and a half, and in the operation one liter of water is allowed to pass very slowly from the jar above into the lower one. This causes a displacement of air; in other words, one liter of air in the lower jar is forced out through the tube shown at the left into the soil and the length of time it takes this liter of air to pass through certain soils is recorded. By using soils of different texture different values are obtained. The soils in an experiment of this nature are usually placed in metal cylinders of about 500 c.c. capacity, but lamp chimneys provided with corks at the bottom may be substituted, if necessary.

Connecting the tube with the lower jar there is a water manometer containing an inch or two of water in each arm, which determines the pressure of the air due to resistance to pressure through the soil, and when one liter of air is passed from the upper bell-jar into the jar below and the water columns remain precisely on a level, exactly one liter of air has been passed through the soil. The contrivances often used for this purpose are so clumsy and constructed on such poor mechanical principles that it is impossible to get the same results from the same soil twice, but by the use of the device described above, very reliable results are obtainable.

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Mr. J. A. Udden, of Rock Island, Illinois, reports in *Science* for July 31, a fossil cycad found in the Upper Cretaceous of Texas Eight fragments of what was presumably the same silicified trunk were found, three of these matched by their fractures and showed a stem about ten inches wide, hollow, and considerably flattened.

The *Century* for September has an illustrated article on the Future Wheat Supply of the United States, written by Edward C. Parker, Assistant at the Agricultural Experiment Station of the University of Minnesota. The methods of the wheat breeder are clearly described, and besides the economic information indi-